SEASONAL CAPTURES AND DIVERSITY OF GROUND BEETLES (COLEOPTERA: CARABIDAE) IN A WHEAT FIELD AND ITS GRASSY BORDERS IN CENTRAL SASKATCHEWAN[1]

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ABSTRACT

Pitfall trapping, at weekly intervals from spring to autumn during a 2-year period in a wheat field and its grassy borders near Clavet, Saskatchewan, captured 87 species of carabids in 25 genera. Seven percent of these species were captured only in the field, 30% only in the field border and 63% in both habitats. Bembidion obscurellum *Mtsch.*, Bembidion quadrimaculatum oppositum *Say*, Bembidion nitidum *Kby.*, Amara lacustris *Lec.*, Amara carinata *Lec.*, Amara farcta *Lec.*, Harpalus herbivagus *Say and* Pterostichus lucublandus *Say were dominant in both habitats, while* Bembidion timidum *Lec. was dominant only in the field,* and Amara quenseli *Schnh. and* Amara obesa *Say, were dominant only in the border. The overall sex ratio in the four collections was about 1:1. However, data for some species differed considerably from this ratio.*

Species diversity and evenness were higher for the field border collections than for collections from the field. An average of about 15 species per week was trapped in the border compared to an average of 11 species per week in the field.

RÉSUMÉ

Le Piégeage em fosses-collectionneuses dans un champs de blé sis près de Clavet, Saskatchewan, et dans les bordures herbeuses de de celui-ci, aux écartements d'une semaine à partir du printemps jusqu' à partir du printemps jusqu' à l' automne pendant deux ans, a pris 87 espèces de carabidés. reparties en 25 genres. En proportion, les espèces prises ont été comme suit: seulement dans le champs, 7 p.c.; seulement dans les bordures, 30 p.c.; et à la fois dans le champs et dans les bordures, 63 p.c. Bembidion obscurellum *Mtsch.*, Bembidion quadrimaculatum oppositum *Say*, Bembidion nitidum *Kby.*, Amara lacustris *Lec.*, Amara carinata *Lec.*, Amara farcta *Lec.*, Harpalus herbivagus *Say et* Pterostichus lucublandus *Say étaient prédominantes parmi les espèces qui se sont trouvées dans les deux habitats, tandis que* Bembidion timidum *Lec. a prédominé parmi celles qui se sont rencontrées seulement dans le champs et* Amara quenseli *Schnh. et* Amara obesa *Say ont prédominé parmi celles qui ont demeurées dans les bordures. La proportion sexuelle globale de quatre collections a été approximativement en rapport de 1:1, cependant, cette proportion a souvent varié considérablement de ce niveau dans le cas des espéces particulières.*

La diversité et l'uniformité des espèces ont été plus élevées dans les collections prises des bordures que dans celles des champs. Une moyenne de 15 espèces par semaine a été captée dans les bordures à comparer à 11 espèces par semaine en moyenne dans le champs.

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INTRODUCTION

Investigations of the way of life of carabids associated with agricultural lands have usually been conducted to determine the potential importance of dominant species as predators and their possible role in the population dynamics of crop pests (Rivard 1964; Frank 1971a; Kirk 1971a; Esau and Peters 1975; Finlayson and Campbell 1976; Holliday and Hagley 1978). It is also important to determine species composition, population structure and diversity of carabid populations associated with various habitats, including arable lands. This information is potentially useful for assessing impact of agricultural or other practices on stability of carabid populations. Temporal changes or spatial differences in diversity could be a valuable biological index for assessing effect of agronomic practices on carabid populations (Dritschilo and Wanner 1980).

Carabids are known to attack wireworm larvae (Fox and MacLellan 1956) and are potential predators of all stages of wireworms. This paper reports on pitfall trapping for carabids in a wireworm infested field in Central Saskatchewan to determine: (1) dominant species that might be important as predators of wireworms; (2) the species composition and diversity of collections. For comparison, similar collections were made in the uncultivated field border which also harboured a wireworm population. Observations on the sex ratio and seasonal occurrence of some species are also included.

METHODS

The general methods, plot arrangement, plot size, and vegetation surrounding the study field (52° 02′ N., 106° 24′ W.) near Clavet, Saskatchewan, were as described previously (Doane and Dondale 1979). The field study, cultivated and seeded to spring wheat in June in 1975 and 1976, was harvested each year in late August and early September.

A pitfall trap was placed at the centre of each of 16 field plots and 15 field border plots. Carabids were trapped in these two habitats for a 48-hr period each week, usually from Monday until Wednesday, from April or May until mid-October, giving a total of 44 and 56 trap-days in 1975 and 1976 respectively. During the remainder of the week, traps remained in place, but carabids captured were released in order to avoid possible over trapping of some species. Sex of all carabids trapped was determined, and for species that comprised one per cent or more of the total annual collection from each habitat, chi-square analysis was used to test conformity to a 1:1 male-female ratio.

Abundance of different species within collections was expressed as a percentage of the total collection for each year and habitat. To allow better comparison between years and habitats, in which different numbers of trap-days and traps were used respectively, total seasonal catch per species was also expressed as captures per metre of trap circumference per trap-day, since trap circumference is one factor influencing number of captures (Turner 1962; Thomas and Sleeper 1977). The inside rim of the pitfall trap used in the present studies, described previously (Doane 1961), had a circumference of 51.496 cm giving a total trapping circumference of 8.24 m (16 traps) and 7.72 m (15 traps) in the field and field border respectively.

Diversity and evenness of carabid collections made for the two years and sites was determined using the Brillouin diversity index (H) and Simpson's index of diversity (D) (Pielou 1969). Choice of the Brillouin index has been discussed previously for similar spider collections (Doane and Dondale 1979). The Brillouin index was calculated using a table compiled by Lloyd *et al.* (1968), while maximum diversity (Hmax) and evenness was determined by using

equations given by Pielou (1969). Simpson's measure of diversity (D) (Pielou 1969) was used for comparison since it is worthwhile to have more than one measure of diversity.

RESULTS AND DISCUSSION

Abundance and seasonal diversity

Numbers of genera and species captured in each habitat for each year, were quite consistent (Table 1). More individuals were captured in 1976 in both the field and its border, but on the basis of numbers trapped per metre of trap circumference per trap-day the greatest numbers were trapped in 1975 in the field (Table 2). Eighty-seven species were found in the four collections (Table 2); of these 7% were collected only from the field, 30% only from the field border and, 63% from both habitats.

Dominant species, those that comprised 3% or more of the total individuals in at least one of the collections (Table 2), were the following: *Bembidion obscurellum* Mtsch., *Bembidion quadrimaculatum oppositum* Say, *Bembidion nitidum* Kby., *Bembidion timidum* Lec., *Amara lacustris* Lec., *Amara carinata* Lec., *Amara fracta* Lec., *Amara quenseli* Schnh., *Amara obesa* Say, *Harpalus herbivagus* Say and *Pterostichus lucublandus* Say. Of these, *B. timidum* was dominant only in the field and *A. quenseli* and *A. obesa* were dominant only in the border; the remainder were dominant in both habitats.

For convenience, species abundance and seasonal occurrence are discussed under generic groupings. Seasonal activity of dominant species that were trapped at Clavet, Saskatchewan, agreed closely with that observed by Frank (1971a) for the same or congeneric species occurring in Alberta.

Bembidion

Eighteen species were captured in the field and field border during the 2-year study period, eight species in the field and 17 in the field border. *B. obscurellum* was by far the most abundant species collected in the field in 1975, comprising about 40% of the total individuals in the collection (Table 2), and about 85% of the individuals in that genus. Collection rate of 3.15/m trap circumference/trap-day was the greatest for any species during either year. In 1976, captures of *B. q. oppositum* were slightly in excess of *B. obscurellum* in the field. More rare species of *Bembidion* were trapped in the field border than in the field.

Frank (1971a) captured 11 *Bembidion* species in a cultivated field at Calahoo, Alberta (about 32 km northwest of Edmonton). There, *B. q. oppositum* was the most abundant species followed by *B. obscurellum*, *B. rupicola*, *B. nitidum* and *B. bimaculatum*. *Bembidion rupicola* was rarely trapped in Saskatchewan at Clavet.

At Clavet, *Bembidion* species were mainly active during mid-summer until about the first week in August, when activity, as determined by pitfall captures, ceased abruptly. A small amount of activity resumed in the late fall. *Bembidion bimaculatum*, collected in small numbers at Clavet, was an exception in that it was active mainly from mid-summer on. The main period of mating for the most abundant species *B. obscurellum* appeared to be in June, assuming that the observed increased male activity during that period reflected mating activity. Chi-square analysis showed that males were in excess of females ($P<0.05$) on June 4, June 18 and on July 2; on the latter date, 208 males and 113 females were captured. For the other 10 weekly collections so analyzed, the male-female ratio for *B. obscurellum* did not differ from a

1:1 expectation. *Bembidion quadrimaculatum oppositum* was the second most abundant *Bembidion* species in the field collection in 1975, and in 1976 exceeded *B. obscurellum* in numbers.

Amara

The genus *Amara* was represented by 18 species in the two habitats; 15 were collected in the field and 17 in the border. *Amara lacustris* and *A. carinata* were the most abundant species in the field (Table 2). *A. latior* and *A. fracta* were slightly more abundant in the field than the border while, *A. quenseli* and *A. obesa* were captured more often in the border. Species such as *A. apricaria* and *A. littoralis* were captured regularly, but in low numbers, while others were extremely rare (Table 2).

In Alberta, Frank (1971a) found many of the same species, but the most abundant in Saskatchewan, *A. lacustris*, was rare at Calahoo, and *A. carinata* very abundant at Clavet, was not found at the Alberta site. *Amara torrida*, common in Alberta, was extremely rare at Clavet.

The seasonal activity peaks of most of the *Amara* species occurred in late summer and fall, the same general pattern observed by Frank (1971a). However, there was some variation from this predominant activity period exhibited particularly by *A. fracta*. In 1975, *A. fracta* was active mainly from September to the close of the season, but in 1976, peak captures occurred in April and again in midsummer, with relatively few captures in the fall.

Harpalus

Nine species of *Harpalus* were trapped, but of these, only *H. herbivagus* was abundant in collections; it was taken regularly in both the field and border habitats. Lindroth (1968) considered this species rare on the prairies where he considered *Harpalus pleuriticus* Kby. more common. Frank (1971a) found *H. pleuriticus* second in abundance to *H. amputatus* but did not capture *H. herbivagus*.

Harpalus herbivagus had a long period of activity during the season with several pronounced peaks that varied somewhat in the two seasons. In 1975, this carabid was caught throughout the early part of the season in low numbers, and after July, captures per week steadily increased to a peak about the third week in September. In 1976, however, it was abundant in field traps from April to mid-July and was then captured in low numbers to the end of the season. In the border, the same general pattern was observed, except that fewer beetles were trapped, and the peak captures were observed about mid-June. Teneral *H. herbivagus* adults were observed from mid-September until the end of the season.

Pterostichus

Pterostichus lucublandus was the most abundant of the five species trapped (Table 2). This is an extremely widespread species described as transamerican (Lindroth 1966) and extending south and east at least to North Carolina (Kirk 1971b). At Clavet it was found from early May to October in both the field and field border. Peak activity occurred from about the end of May until the first of July and then again from about the first week in August until late September. In general, the peaks of activity agreed very closely with the pattern of activity described by Kirk (1971b). Frank (1971a) concluded that this species was only active from May to July, but noted a second peak one year. However, Kirk's observations and those made at Clavet confirm the existence of two activity peaks. The second peak is at least partially composed of young adults, many of which were teneral in September at Clavet. Adults trapped in the fall may be a mixture of newly emerged beetles and those of the previous generation (Kirk 1971b).

Agonum

Although five species of *Agonum* were trapped, few individuals per species were taken. Frank (1971a) found *Agonum cupreum* Dej. and *Agonum placidum* Say, two of the same species trapped at Clavet, to be quite common in Alberta.

Sex ratios

The male:female sex ratio for the 8741 carabids in the four collections, i.e., field and field border 1975, and 1976, were 48:52, 48:52, 53:47 and 50:50% respectively. Rivard (1966), for a collection of 10,000 carabids made over a 3-year period, observed a male:female ratio of 57:43 per cent. Although overall sex ratio of beetles trapped at Clavet was about 1:1, several species did not conform to this ratio (Table 3). Usually males were in excess of females; exceptions were *A. carinata* for which females were in excess of males in all four collections and *P. lucublandus* for which females outnumbered males in three of the four collections (Table 3).

Disproportionate numbers of *A. carinata* males and females (overall about 3.5 times fewer males than females) points to unknown characteristics in the life-cycle or activity that appear to differ considerably from most of the species collected.

Diversity

Diversity and evenness were higher for the seasonal collections from the field in 1976 than in 1975 and, higher in the border collections in 1975 than in 1976 (Table 4). Both years, diversity of the border collections was greater than that of the field collections. Although, total numbers of species in the two habitats ranged from 45 to 66 (Table 1) during the two years, considerably fewer species were captured in any one week (Table 5). More species per week were captured in the border, but more individuals per week were trapped in the field.

Higher diversity of carabid species in the field border than in the field appears to be consistent with the higher variety of plant and insect life in the uncultivated habitat. Lewis (1969) observed that insect diversity was highest in hedgerows and that it declined in adjacent crops as the distance from the hedgerow increased. Uncultivated lands therefore appear to be important to the ecology of adjacent crops by providing niches and shelter both for beneficial and pest species (Lewis 1965). Such areas may also provide alternate prey for predators when pest species are not available as prey in the field (van Emden 1965). At Clavet, 63 per cent of all carabid species were captured in both the field and its borders. Therefore, considerable movement likely occurs between the two habitats. This suggests that the uncultivated border may serve as shelter and a source of alternate prey for some species if the field becomes an unsuitable habitat, as for example, during periods of summerfallowing.

Numbers of genera and species trapped each year in the field and its border (Table 1) and the average numbers of species trapped in these habitats per week (Table 5) were remarkably constant even for the field. Numbers of species in a habitat tend to reach an equilibrium depending upon the habitat structure (MacArthur 1965). Thus, an approximately constant number of species occur in the field and a few more in the field border as dictated by the available resources and structure of the habitat.

Diversity indices of collections from the two habitats provide a convenient measure of carabid species numbers and the relationship between the numbers of species and individuals within species. Although these measures of diversity apply only to collections from the study

field and its borders, they will provide baseline information for studies in other fields and areas of Saskatchewan when a similar collection method is used.

Potential of carabids as predators

Many species of carabids are primarily phytophagous (Johnson and Cameron 1969; Thiele 1977), so that food preferences of dominant species and their response to potential prey require detailed study before the value of dominant species as predators can be assessed. Best and Beegle (1977) investigated the feeding of five species of carabids on a variety of plant and animal food in the laboratory and concluded that dead black cutworm larvae (*Agrotis ipsilon* (Hüfnagel)) were preferred by all the species tested. Frank (1971b) investigated the potential of carabids from a cultivated field in Alberta as predators of eggs of the red-backed cutworm (*Euxoa ochrogaster* Guenée) and reported that 21 species consumed eggs. These included species of *Bembidion* (8), *Amara* (7), *Agonum* (2), *Harpalus* (2), *P. lucublandus* and *Trichocellus cognatus* Gyll.. Serological tests showed that seven species fed on cutworm larvae or pupae in the field. Natural predation by carabids on wireworm larvae in pastures has also been demonstrated by the precipitin test (Fox and MacLellan 1956). Predatory species included members of the genera *Agonum*, *Amara*, *Harpalus* and *Pterostichus*.

Perhaps the greatest chance for carabid predation in cultivated fields in Saskatchewan would be upon wireworm eggs and newly hatched larvae. The main period of oviposition in the field of the prairie grain wireworm, *Ctenicera destructor* (Brown), occurs from about the third week in May until mid-June (Doane 1963). These beetles lay eggs under clods of soil in summerfallow fields and in soil cracks (Doane 1967). Such eggs would be exposed to predation when at least four species of *Bembidion*, i.e., *B. obscurellum*, *B. q. oppositum* , *B. nitidum* and *B. timidum* are at peak populations and activity levels in the field. *Bembidion* species fed on eggs of the red-backed cutworm (Frank 1971b) while, in Ontario, *B. q. oppositum* and *B. nitidum* were shown to be predators of eggs of *Hylemya brassicae* (Bouché), the cabbage maggot (Wishart, Doane and Maybee 1956). The role of *Bembidion* species as potential predators of the egg and early larval stages of wireworms, therefore, is worthy of investigation.

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Table 1. Summary of individuals, species and genera of carabids captured in pitfall traps in a wheat field and its borders near Clavet, Sask. from spring to autumn, 1975–76

Site	No. of individuals[a]	Mean per Mean per trap[b]	No. of genera	No. of species
1975				
Field	2810	175.8	16	45
Field border	1215	81.0	23	66
1976				
Field	2957	184.8	16	51
Field border	1757	117.1	22	66

[a]Total captured in 44 and 56 days of trapping in 1975 and 1976 respectively.

[b]16 traps in the field and 15 traps in the field border.

Table 2. Species of carabids captured in pitfall traps expressed as number/meter trap circumference/trap day, and per cent of total captures, for collections made in a wheat field and its borders in 1975 and 1976 at Clavet, Saskatchewan[1]

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Bembidion obscurellum Mtsch.	3.15	40.64	0.112	3.13	0.596	9.30	0.085	2.10
Bembidion quadrimaculatum oppositum Say	0.292	3.77	0.450	12.59	0.661	10.32	0.178	4.38
Bembidion nitidum Kby.	0.138	1.78	0.403	11.28	0.214	3.35	0.259	6.37
Bembidion timidum Lec.	0.135	1.74	0.044	1.23	0.254	3.96	0.030	0.74
Bembidion bimaculatum Kby.	0.025	0.32	0.103	2.88			0.018	0.45
Bembidion nudipenne Lth.	0.014	0.18	0.003	0.08	0.041	0.64	0.005	0.11
Bembidion muscicola Hayw.			0.003	0.08			0.005	0.11
Bembidion acutifrons Lec.			0.003	0.08			0.002	0.06

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(Table 2 continued)

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Bembidion mutatum G. & H.			0.044	1.23			0.016	0.40
Bembidion concretum Csy.			0.003	0.08				
Bembidion bifossulatum Lec.			0.003	0.08				
Bembidion nigripes Kby.			0.009	0.25			0.002	0.06
Bembidion aeneicollis Lec.			0.006	0.16				
Bembidion obtusangulum Lec.			0.003	0.08			0.002	0.06
Bembidion coloradense Hayw.					0.002	0.03		
Bembidion rupicola Kby.					0.004	0.07		
Bembidion canadianum Csy.							0.007	0.17

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(Table 2 continued)

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Bembidion roosvelti Pic.							0.009	0.23
Bembidion (Trepanedoris) sp.							0.002	0.06
Amara lacustris Lec.	1.134	14.61	0.035	0.98	0.709	11.06	0.197	4.84
Amara carinata Lec.	0.690	8.89	0.126	3.54	0.448	7.00	0.224	5.52
Amara quenseli Schnh.	0.163	2.10	0.185	5.18	0.050	0.78	0.305	7.51
Amara farcta Lec.	0.152	1.96	0.112	3.13	0.813	12.68	0.240	5.92
Amara latior Kby.	0.146	1.88	0.059	1.65	0.087	1.35	0.056	1.37
Amara obesa Say	0.138	1.78	0.206	5.76	0.028	0.44	0.122	3.02
Amara apricaria Payk.	0.072	0.92	0.024	0.66	0.054	0.85	0.018	0.46

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(Table 2 continued)

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Amara littoralis Mnh.	0.008	0.11	0.015	0.41	0.013	0.20	0.021	0.51
Amara ellipsis Csy.			0.006	0.16	0.020	0.30	0.079	1.94
Amara coelebs Hayw.					0.002	0.03	0.018	0.46
Amara musculis Say							0.025	0.63
Amara confusa Lec.	0.008	0.11			0.011	0.17	0.005	0.11
Amara convexa Lec.							0.012	0.28
Amara cupreolata Putz.					0.006	0.10	0.005	0.11
Amara pallipes Kby.	0.003	0.04	0.009	0.25			0.002	0.06
Amara scitula Zimm.	0.003	0.04	0.079	2.22	0.039	0.61	0.005	0.11

(Table 2 continued)

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Amara patruelis Dej.	0.003	0.04	0.003	0.08	0.004	0.07	0.037	0.91
Amara torrida Panz.	0.003	0.04			0.002	0.03		
Harpalus herbivagus Say	0.243	3.13	0.215	6.00	1.250	19.51	0.474	11.67
Harpalus amputatus Say	0.088	1.14	0.015	0.41	0.091	1.42	0.016	0.40
Harpalus funerarius Cki.	0.039	0.50	0.012	0.33	0.015	0.24	0.009	0.23
Harpalus carbonatus Lec.	0.006	0.07	0.006	0.16	0.002	0.03	0.032	0.80
Harpalus desertus Lec.	0.006	0.07	0.003	0.08				
Harpalus ventralis Lec.	0.003	0.04	0.018	0.49	0.004	0.07	0.009	0.23
Harpalus opacipennis Hald.			0.035	0.99	0.002	0.03	0.035	0.85

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(Table 2 continued)

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Harpalus pleuriticus Kby.			0.003	0.08	0.006	0.10		
Harpalus uteanus Csy.							0.002	0.06
Pterostichus lucublandus Say	1.015	13.08	0.733	20.49	0.854	13.32	1.073	26.41
Pterostichus femoralis Kby.	0.014	0.18	0.029	0.82	0.013	0.20	0.016	0.40
Pterostichus corvus Lec.	0.008	0.11	0.003	0.08	0.011	0.17	0.016	0.40
Pterostichus adstrictus Eschz.	0.003	0.04			0.002	0.03		
Pterostichus pensylvanicus Lec.			0.003	0.08				
Agonum cupreum Dej.	0.008	0.11	0.026	0.74	0.002	0.03	0.017	0.40
Agonum cupripenne Say			0.047	1.32			0.002	0.06
Agonum placidum Say			0.018	0.49	0.002	0.03	0.011	0.28

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(Table 2 continued)

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Agonum corvus Lec.			0.012	0.33				
Agonum thoreyi Dej.	0.003	0.04	0.006	0.16				
Chlaenius sericeus Forst.			0.012	0.33	0.002	0.03	0.014	0.34
Chlaenius alternatus Horn.	0.003	0.04	0.006	0.16				
Chlaenius pensylvanicus Say			0.012	0.33				
Cymindis cribricollis Dej.	0.003	0.04	0.009	0.25	0.004	0.07	0.009	0.23
Cymindis borealis Lec.	0.003	0.04	0.012	0.33			0.021	0.51
Cymindis planipennis Lec.					0.002	0.03	0.007	0.17

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(Table 2 continued)

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Bradycellus nigerrimus Lth.					0.006	0.10	0.067	1.65
Bradycellus congener Lec.					0.013	0.20	0.009	0.23
Bradycellus lecontei Cki.							0.007	0.17
Stenolophus conjunctus Say	0.003	0.04			0.002	0.03	0.002	0.06
Stenolophus comma F.	0.003	0.04	0.006	0.16	0.002	0.03		
Trichocellus cognatus Gyll.			0.003	0.08			0.002	0.06
Anisodactylus sanctaecrucis F.	0.008	0.11	0.106	2.96	0.013	0.20	0.062	1.54
Anisodactylus nigrita Dej.			0.003	0.08	0.002	0.03		
Calosoma lepidum Lec.	0.003	0.04	0.009	0.25	0.002	0.03	0.002	0.06
Calosoma obsoletum Say	0.006	0.07			0.002	0.03		

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(Table 2 continued)

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Carabus serratus Say			0.012	0.32	0.004	0.07	0.014	0.34
Carabus taedatus F.	0.003	0.04	0.012	0.32			0.011	0.28
Elaphrus californicus Mnh.			0.021	0.58				
Elaphrus lecontei Crotch							0.002	0.06
Metabletus americanus Dej.			0.035	0.99	0.006	0.10	0.044	1.08
Microlestes linearis Lec.			0.015	0.41	0.026	0.40	0.042	1.02
Calathus ingratus Dej.	0.003	0.04	0.003	0.08	0.002	0.03	0.007	0.17
Patrobus lecontei Chd.	0.003	0.04	0.009	0.25	0.002	0.03	0.005	0.11

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(Table 2 continued)

Species	Field–1975		Field Border–1975		Field-1976		Field border-1976	
	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures	No./m trap circum./trap day	% of total captures
Harpalellus basilaris Kby.	0.003	0.04	0.003	0.08			0.009	0.23
Dipocheila striatopunctata Lec.	0.003	0.04	0.038	1.07			0.002	0.06
Loricera pilicornis F.			0.006	0.16			0.002	0.06
Notophilus aquaticus L.			0.009	0.25			0.014	0.34
Dyshirius integer Lec.			0.003	0.08				
Euryderus grossus Say			0.003	0.08				
Blethisa multipunctata L.	0.003	0.04						
Total	7.763		3.579		6.402		4.057	

[1] Sixteen traps in the field and 15 traps in the field border gave a total trap circumference of 8.24 and 7.72 m respectively; number of trap days were 44 in 1975 and 56 in 1976; i.e., 3.15 x 8.24 x 44 = 1142, the number of *B. obscurellum* trapped in the field in 1975.

Table 3. Total seasonal captures of male and female carabids and chi-square analysis testing the hypothesis of a 1:1 male:female ratio for species that comprised one percent or more of the collections made in a wheat field and its borders near Clavet, Sask.

Species	Field–1975			Field Border–1975			Field-1976			Field border-1976		
	Males	Females	x^2	Males	Females	x^2	Males	Females	x^2	Males	Females	x^2
B. q. oppositum	58	48	0.94	79	74	0.16	165	140	12.05	42	35	0.64
B. obscurellum	637	505	15.26**	25	13	3.79	168	107	13.53**	17	20	0.24
B. nitidum	27	23	0.32	65	72	0.36	68	31	13.82**	65	47	2.90
B. timidum	30	19	2.46	5	10	1.66	84	33	22.23*	-	-	-
B. mutatum	-	-	-	8	7	0.07	-	-	-	-	-	-
B. bimaculatum	-	-	-	18	17	0.06	-	-	-	-	-	-
A. farcta	22	33	2.20	21	17	0.42	225	150	15.00**	58	46	1.38
A. obesa	25	25	0.00	46	24	6.91**	-	-	-	30	23	0.92
A. latior	16	37	8.32	11	9	0.20	18	22	0.40	9	15	1.50
A. quenseli	29	30	0.02	32	31	0.16	-	-	-	80	52	5.94*
A. carinata	42	208	110.22**	6	37	22.35**	68	139	24.36**	18	79	38.36**
A. lacustris	200	211	0.29	-	-	-	170	157	0.52	37	48	1.42
A. scitula	-	-	-	11	16	0.93	-	-	-	-	-	-
A. ellipsis	-	-	-	-	-	-	-	-	-	22	12	2.94
H. amputatus	21	9	4.80*	-	-	-	29	13	6.10*	-	-	-
H. herbivagus	46	42	0.18	31	42	1.65	318	259	6.03*	85	120	5.98*
P. lucublandus	151	217	11.84*	113	136	2.12	172	222	6.34*	246	218	1.69
A. cupripenne	-	-	-	8	8	0.00	-	-	-	-	-	-
A. sanctaecrucis	-	-	-	15	21	1.00	-	-	-	8	19	4.48*
D. striatopunctata	-	-	-	7	6	0.08	-	-	-	-	-	-

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(Table 3 continued)

Species	Field–1975			Field Border–1975			Field-1976			Field border-1976		
	Males	Females	x^2	Males	Females	x^2	Males	Females	x^2	Males	Females	x^2
B. nigerrimus	-	-	-	-	-	-	-	-	-	16	13	0.31
M. americanus	-	-	-	-	-	-	-	-	-	7	12	1.32
M. linearis	-	-	-	-	-	-	-	-	-	10	8	0.22

* and ** indicate significant departure from a 1:1 ratio at the 5 and 1% levels respectively (df=1).

Table 4. Simpson and Brillouin diversity indices for carabid collections from a wheat field and its borders near Clavet, Saskatchewan

Site	D[a]	H[b]	Hmax[c]	Evenness[d]	D	H	Hmax	Evenness
		1975				1976		
Field	0.784	0.888	1.633	0.544	0.888	1.065	1.686	0.632
Field border	0.914	1.270	1.765	0.720	0.893	1.228	1.779	0.690

[a]Simpson's diversity index (see Pielou 1969).

[b]Brillouin index, calculated using $\log_{10}$ (see Pielou 1969)

[c]Maximum diversity possible for the observed population.

[d]Evenness given by H/Hmax (see Pielou 1969).

Table 5. Mean numbers of individuals and species of carabids captured in pitfall traps each week in a wheat field and its borders near Clavet, Saskatchewan, 1975 and 1976.

Site	Individuals Mean(S.E.)	Species Mean(S.E)
1975		
Field	140.5 (84.74)	10.5 (0.71)
Field border	55.2 (6.81)	14.2 (1.16)
1976		
Field	105.6 (16.22)	11.5 (0.80)
Field border	62.8 (7.13)	15.2 (0.76)